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(57) A closure assembly comprises a container neck 1, the inner wall 7 of which tapers and a closure for said neck, the closure having a base portion 3 a skirt portion 4, complementary screw threads, a sealing plug 8 and at least one sealing fin 10/11. The sealing plug depends from the base portion of the closure and is provided with at least two sealing ribs 9 that engage with the inner surface of the container neck when the closure is secured on the container neck. The at least one sealing fin may extend radially inwards 11 or outwards 10 for engagement with the lip of the container neck. The closure may be secured and resecured on the container neck by a single smooth rotation of 360° or less, 180° or less or about 90° and the complementary screw threads may vary in pitch. The closure assembly may further comprise complementary locking elements on the closure and neck to resist unscrewing until a minimum opening torque is applied and there may be provided a projecting stop surface on one of either the closure or the neck so as to prevent over-tightening of the closure. The closure may be provided with a further sealing rib 14 located on an inner surface of the closure skirt for engagement with the outer surface of the container neck. The closure assembly is especially suitable for carbonated beverage containers.

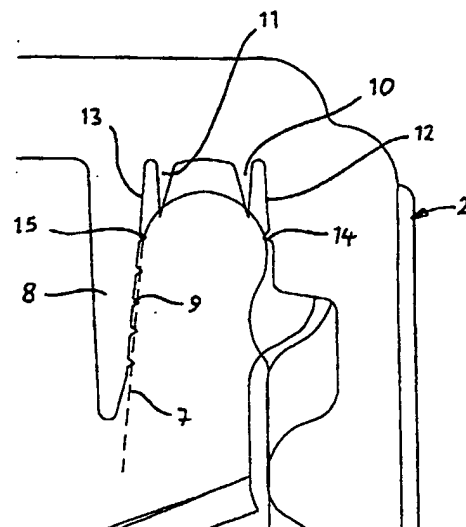
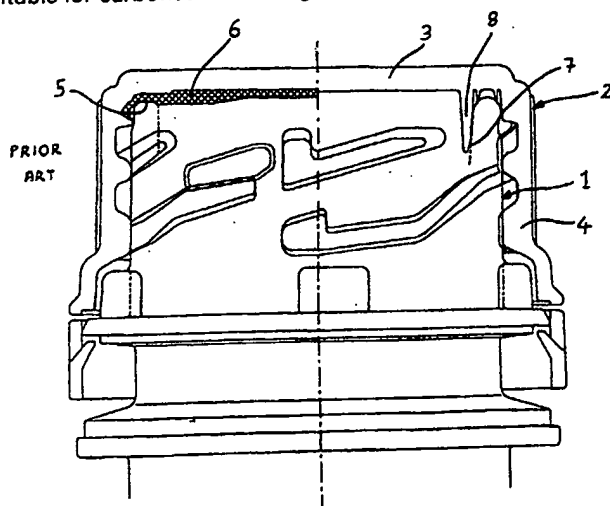
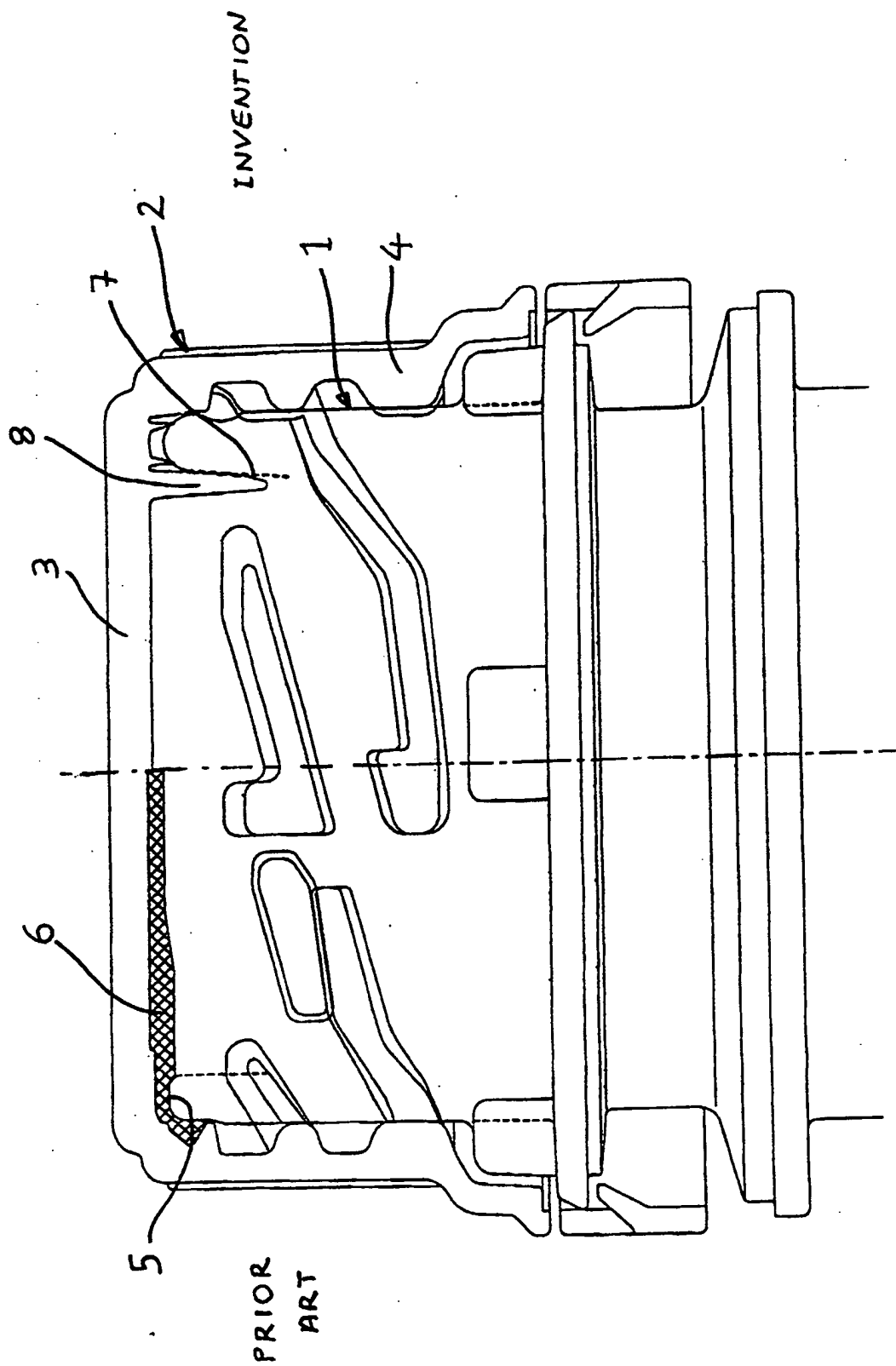


FIG. 2

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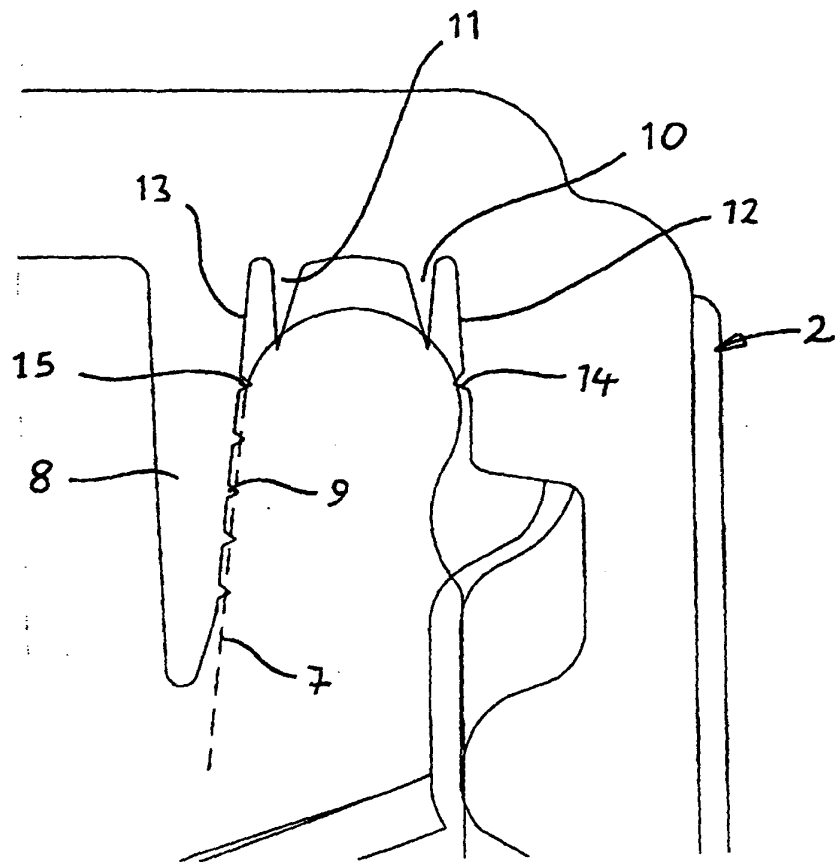


FIG. 2

## PLUG SEALS FOR USER-FRIENDLY CAP ASSEMBLIES

The present invention relates to improved seals for container closure  
5 assemblies. The invention is especially applicable to the sealing of containers in  
substantially gas-tight and liquid-tight fashion, such as the sealing of carbonated  
and non-carbonated beverage containers.

It is well known to provide beverage containers of glass, paper, card, metal  
10 or plastic having a screw top that can be resecured on the bottle neck. It is  
desirable to provide such containers with a screw top closure assembly that  
provides an airtight and liquid-tight seal to retain the quality of the beverage both  
during initial transport and storage, and after partial consumption of the contents  
when the closure has been resecured onto the container neck.

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Certain existing container and closure assemblies make use of an  
elastomeric liner in the base of the closure cap. This liner is pressed against the  
lip of the bottle neck when the cap is screwed firmly onto the bottle neck, and the  
compression between the soft, deformable liner and the lip of the container  
20 provides a tight seal. Unfortunately, the manufacture and insertion of the liner into  
the closure cap are relatively costly additional process steps. Furthermore, care  
must be taken not to over-tighten such closures onto the container neck, since the  
liner can become brittle or damaged if excessive pressure is applied thereto.

25 It is also known to provide a cylindrical plug seal projecting downwardly  
from the base of the closure cap, such that the plug forms an interference fit with  
an inner surface of the bottle neck close to the lip of the bottle. Effective sealing  
by such plug seals requires the cap to be screwed down very tightly on the  
container neck in order to deform the base of the cap and thereby force the plug  
30 radially outwardly into a tight sealing engagement with the container neck. It is  
very often the case that such caps are under-tightened, especially by children and  
elderly users. Furthermore, a sufficient sealing force can only be achieved by the  
use of threads on the cap and the neck having a low pitch, such that the closure

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torque applied to the cap is leveraged into a very strong downward sealing force between the lip of the container and the closure base.

A need, therefore, exists for a screw-top container and closure arrangement that  
5 can provide an effective seal without the need for a liner, and also without the need for a strong axial sealing force between the container neck and the closure.

The present invention provides a container closure assembly comprising: a  
container neck having side walls defining an opening at one end thereof and a lip  
10 extending around the opening, wherein an inner surface of the side walls proximate to said lip is inwardly tapered; a closure for the neck, the closure having a base portion and a skirt portion; a first screw thread on the neck; a second screw thread on an inner surface of the skirt of the closure; said first and second screw threads being configured to enable a user to secure, remove and resecure  
15 the closure into a sealing position on the neck by rotation of the cap on the neck; a sealing plug extending from the base portion of the closure inside and substantially concentric with the skirt portion of the closure, wherein the sealing plug comprises a plurality of circumferential sealing ribs on an outer surface of said sealing plug for engagement with said inner surface of the container neck  
20 when the closure is secured on the container neck; and at least one flexible sealing fin between the sealing plug and the closure skirt for engagement with the lip of the container when the closure is secured on the container neck.

Preferably, the closure assembly according to the present invention is applied to a  
25 carbonated beverage container, such as a moulded plastic or glass carbonated beverage bottle.

The use of multiple sealing ribs on a plug seal in conjunction with a tapered inner sealing surface on the container neck is new, and provides surprisingly improved  
30 sealing at low sealing forces. Preferably, there are at least two of said sealing ribs, more preferably from 3 to 10 of the ribs, and most preferably 4 to 6 ribs. Preferably, the taper of the inner sealing surface of the container neck is from 1° to 10° from the longitudinal axis of the neck, more preferably from 2° to 6°.

Preferably, at least one of the sealing ribs has a substantially triangular cross-section. This enables the sealing force to be concentrated in the tip of the sealing rib to maximise sealing effectiveness. Preferably, at least one of the sealing ribs  
5 has a height in the range of 10 to 500 micrometers, more preferably 50 to 250 micrometers. Such micro sealing ribs are especially effective to concentrate the sealing force and achieve an effective seal with a substantially smooth sealing surface on the container neck. Furthermore, such micro ribs are especially easy to mould in high-speed cap moulding equipment, and to bump off the mould  
10 mandrel of the equipment after moulding.

A further advantage of using multiple sealing ribs on the sealing plug is that the plurality of sealing ribs may have more than one height in order to optimise sealing. For example, the height of the sealing rib closest to the base of the  
15 closure may be greater than the height of the sealing rib remote from the base of the closure. This allows the sealing rib closest to the base of the closure (i.e. closest to the lip of the container) to deform more than the sealing rib furthest from the base of the closure.

20 Preferably, the outer surface of the sealing plug is tapered inwardly from the base of the closure. The mean angle of taper is preferably from  $1^{\circ}$  to  $10^{\circ}$  from the longitudinal axis of the neck, more preferably from  $2^{\circ}$  to  $6^{\circ}$ .

The sealing fins may have their base in the base of the closure between the skirt  
25 and the sealing plug, or they may extend inwardly or outwardly and downwardly from the base of the skirt or the sealing plug. Preferably, at least one of the sealing fins extends in a direction downwardly and outwardly from the base of the closure between the sealing plug and the closure skirt. Preferably, the closure comprises two or four sealing fins extending around the closure in concentric  
30 fashion. Preferably, two sealing fins are disposed substantially symmetrically on either side of the container lip to provide a balanced sealing pinch on the lip.

- Preferably, the container closure assembly comprises a second sealing fin extending downwardly and inwardly from the base of the closure between the sealing plug and the closure skirt. The first and second sealing fins then seal against opposite sides of the container lip, preferably in substantially symmetrical and balanced fashion. The first and second sealing fins flex in opposite directions as the closure is secured onto the container neck. This dual action ensures that at least one, and usually both, of the sealing fins makes a pressure-tight seal against the lip.
- 10 Preferably, the height of the sealing fins is greater than their width at their base. Preferably, the cross-section of the sealing fins is substantially in the shape of an isosceles triangle. Preferably, at least one sealing fin has a height of from 1 to 4 mm.
- 15 The sealing fins alone may lack sufficient resilience to form a secure pressure-tight seal against the top of the container lip. Therefore preferably at least one stop surface is provided proximate to the base of the closure, positioned and arranged such that at least one sealing fin abuts against the stop surface when the closure is secured on the container neck. Preferably, two flexible fins are provided for
- 20 sealing on either side of the container lip, as described above, and two stop surfaces are provided at the bases of the sealing plug and the closure skirt for abutment against each of the sealing fins at the fully secured and pressure-tight position.
- 25 Preferably, the container lip is rounded to provide for easy and comfortable drinking directly from the container neck. It is a further advantage of the present invention that the sealing arrangement is so effective that it can provide a pressure-tight seal on a conventional, rounded container lip.
- 30 Preferably, the container closure assembly according to the present invention further comprises a further circumferential sealing rib on an inner surface of the closure skirt for engagement with an outer surface of the container neck. More preferably, the circumferential sealing rib is located proximate to the base of the

closure, and it is a feature of the sealing arrangement according to the invention that it can provide a reliable pressure-tight seal without strong downward force being applied to the closure as in previous sealing arrangements.

- 5 Preferably, the container and closure further comprise complementary locking elements on the container neck and the closure that block or resist unscrewing of the closure from the fully secured position on the container neck until a predetermined minimum opening torque is applied. More preferably, the locking elements comprise a longitudinal locking rib on one of the container neck or the
- 10 skirt portion of the closure, and a complementary locking ramp on the other of the container neck and the skirt portion of the closure, said locking rib abutting against the retaining edge of the locking ramp when the closure is fully secured on the container neck.
- 15 The locking arrangement helps to prevent the closure from backing off under pressure from inside the container. It also provides a positive click that indicates to the user when the closure has been screwed onto the neck sufficiently to achieve a pressure-tight seal.
- 20 Preferably, the container closure assembly according to the present invention further comprises a projecting stop surface on one of the container neck and the closure skirt for abutment against a second stop or a thread on the other of the container neck or the closure to block over-tightening of the closure beyond a predetermined angular sealing position of the closure on the container neck. The
- 25 stop means acts in conjunction with the locking arrangement to ensure that exactly the right degree of screwing of the closure is achieved in order to provide a pressure-tight seal with the sealing arrangement of the present invention.

Suitable locking and stop arrangements are described in detail in WO 91/18799

30 and WO 95/05322, the active contents of which are expressly incorporated herein by reference.



An embodiment of the present invention will now be described further by way of example with reference to the accompanying drawings, in which:-

5 Figure 1 shows a comparative view of a container neck (in elevation) and a closure (in cross section) secured to the neck in a sealing position, wherein the left side of the closure is shown with a prior art sealing liner and the right side of the closure is shown with a sealing arrangement in accordance with the present invention; and

10 Figure 2 shows a detailed view in cross section of the lip region of a container closure assembly according to the present invention from Figure 1, with the closure at or near the sealing position.

Referring to Figure 1, the container neck 1 and closure 2 are provided with fast-turn, steeply-pitched threads incorporating a pressure safety feature. The details  
15 of the construction and manufacture of these threads is described in detail in our International patent applications WO 95/05322, WO 97/21602 and WO 99/19228, the entire contents of which are expressively incorporated herein by reference. They will not be described further here.

20 The closure 2 comprises a base 3 and a skirt 4. The container neck 1 terminates in a smooth surfaced lip 5. Conventionally, this lip forms a pressure-tight seal with an elastomeric liner 6 shown hatched in the "prior art" portion of figure 1.

Referring to Figures 1 and 2, the improved sealing arrangement according to the  
25 present invention comprises an inwardly tapered inner surface 7 of the container neck adjacent to the lip. A cylindrical sealing plug 8 projects downwardly from the base of the closure cap, and is itself tapered substantially in parallel with the inner surface of the neck. However, instead of a simple interference fit between the sealing plug and the container neck, there are provided six substantially triangular  
30 circumferential continuous sealing ribs 9 on the outer surface of the sealing plug. The circumferential sealing ribs 9 are approximately 150 micrometers high, which enables them to deform slightly in contact with the normally harder material (glass

or PET) of the container neck to form the pressure-tight seal without substantial force having to be applied to the sealing plug to form the seal.

Two flexible sealing fins 10, 11 extend downwardly by about 2mm from the base of the closure between the closure skirt and the sealing plug. The sealing fins flex in opposite directions to form seals substantially symmetrically on either side of the rounded top of the container lip as the sealing position is reached. A tight seal is assured by abutment of the sealing fins 10, 11 against the respective stop surfaces 12, 13.

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Finally, a further circumferential sealing rib 14 is provided on the skirt of the closure close to the base of the closure for engagement with an outer surface of the container closure close to the lip. The shape and size of the sealing rib 14 is preferably similar to the preferred ranges for the sealing ribs 9. Again, the small size of the sealing rib 14 enables an effective seal to be achieved without a high sealing force. Furthermore, the sealing rib 14 is located substantially opposite the sealing rib 15 located closest to the base of the closure on the sealing plug. The sealing ribs 14 and 15 cooperate to pinch the container lip to provide highly effective seals.

20

The sealing arrangement enables the closure to be secured and resecured on the container neck without the need for high torque or low pitched threads to force a seal. There is a complementary locking arrangement on the container neck and the closure as described in the International patent applications listed above to signal to the user by means of a click when a sealing engagement has been achieved. The locking arrangement is also associated with a stop surface to prevent over-tightening of the closure on the neck, but in any case the sealing arrangement according to the invention is less sensitive to over tightening because there is no elastomeric liner.

30

Preferably, the axial force required to secure the closure in a sealing position on the container neck is less than 20 Newtons, more preferably less than 10 Newtons

and most preferably less than 5 Newtons. This makes it easy for children and elderly adults to resecure the closure in sealing fashion, as discussed above.

5 Preferably, the torque required to secure the closure in a sealing position on the container neck is less than 0.2 Nm, more preferably less than 0.05 Nm and most preferably less than 0.02 Nm. This is the torque required to engage the complementary locking arrangement (where present) at the sealing position, or otherwise the force required to substantially eliminate gas leakage at normal carbonated beverage pressure differentials.

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The above embodiment has been described by way of example only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

## CLAIMS

1. A container closure assembly comprising:
  - 5 a container neck having side walls defining an opening at one end thereof and a lip extending around the opening, wherein an inner surface of the side walls proximate to said lip is inwardly tapered;
  - a closure for said neck, the closure having a base portion and a skirt portion;
  - 10 a first screw thread on the neck;
  - a second screw thread on an inner surface of the skirt of the closure;
  - said first and second screw threads being configured to enable a user to secure, remove and resecure the closure into a sealing position on the neck by rotation of the cap on the neck;
  - 15 a sealing plug extending from said base portion of the closure inside and substantially concentric with said skirt portion of the closure, wherein the sealing plug comprises a plurality of circumferential sealing ribs on an outer surface of said sealing plug for engagement with said inner surface of the container neck when the closure is secured on the container neck; and
  - 20 at least one flexible sealing fin between the sealing plug and the closure skirt for engagement with the lip of the container when the closure is secured on the container neck.
2. A container closure assembly according to claim 1, wherein there are at
  - 25 least three of said sealing ribs.
3. A container closure assembly according to claim 2, wherein there are at
  - from 3 to 10 of said sealing ribs.
- 30 ~~4.~~ A container closure assembly according to any preceding claim, wherein at least one of the sealing ribs has a substantially triangular cross-section.

5. A container closure assembly according to any preceding claim, wherein the sealing ribs have a height in the range of 10 to 250 micrometers.

6. A container closure assembly according to any preceding claim, wherein  
5 the plurality of sealing ribs have more than one height.

7. A container closure assembly according to claim 6, wherein the sealing rib furthest from the base of the closure has a greater height than the sealing rib closest to the base of the closure.

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8. A container closure assembly according to any preceding claim, wherein the outer surface of the sealing plug is tapered inwardly from the base of the closure.

15 9. A container closure assembly according to any preceding claim, wherein at least one said sealing fin extends downwardly and outwardly from the base of the closure between the sealing plug and the closure skirt.

10. A container closure assembly according to claim 9, further comprising a  
20 second sealing fin extending downwardly and inwardly from the base of the closure between the sealing plug and the closure skirt.

11. A container closure assembly according to any preceding claim, wherein at least one said sealing fin has a height of from 1 to 4 mm.

25

12. A container closure assembly according to any preceding claim, wherein at least one stop surface is provided proximate to the base of the closure, whereby at least one sealing fin abuts against the stop surface when the closure is secured on the container neck.

30

13. A container closure assembly according to any preceding claim, wherein the container lip is rounded.

14. A container closure assembly according to any preceding claim, further comprising a further circumferential sealing rib on an inner surface of the closure skirt for engagement with an outer surface of the container neck.
- 5 15. A container closure assembly according to claim 14, wherein the further circumferential sealing rib is located at substantially the same height above the base of the closure as one of the circumferential sealing ribs on the sealing plug.
16. A container closure assembly according to any preceding claim, wherein  
10 the closure can be secured and resecured on the container neck by a single smooth rotation through 360° or less.
17. A container closure assembly according to claim 16, wherein the closure  
15 through 180° or less.
18. A container closure assembly according to claim 16, wherein the closure  
can be secured and resecured on the container neck by a single smooth rotation  
through about 90°.
- 20 19. A container closure assembly according to any preceding claim, wherein the first and second threads are multiple start threads.
20. A container closure assembly according to any preceding claim, wherein  
25 the first and second threads are continuous helical threads having a mean thread pitch of from 5° to 25°.
21. A container closure assembly according to any preceding claim, wherein  
the container and closure further comprise complementary locking elements on  
30 the container neck and the closure that block or resist unscrewing of the closure from the fully secured position on the container neck until a predetermined minimum opening torque is applied.

22. A container closure assembly according to claim 21, wherein the locking elements comprise a longitudinal locking rib on one of the container neck or the skirt portion of the closure, and a complementary locking ramp on the other of the container neck and the skirt portion of the closure, said locking rib abutting against the retaining edge of the locking ramp when the closure is fully secured on the container neck.

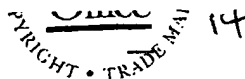
23. A container closure assembly according to any preceding claim, further comprising a projecting stop surface on one of the container neck and the closure skirt for abutment against a second stop or a thread on the other of the container neck or the closure to block over-tightening of the closure beyond a predetermined angular sealing position of the closure on the container neck.

24. A container closure assembly according to any preceding claim, wherein the axial force required to secure the closure in a sealing position on the container neck is less than 10 Newtons.

25. A container closure assembly according to any preceding claim, wherein the torque required to secure the closure in a sealing position on the container neck is less than 0.05 Nm.

26. A beverage container comprising a container closure assembly according to any preceding claim.

27. A beverage container according to claim 26 which is a carbonated beverage container.



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Application No: GB 0028346.5  
Claims searched: 1-27

Examiner: Mike Leaning  
Date of search: 11 April 2001

## Patents Act 1977 Search Report under Section 17

### Databases searched:

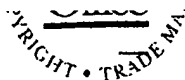
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UK Cl (Ed.S): B8T (TBM, TCM, TCP, THRS)  
Int Cl (Ed.7): B65D (39/04, 39/08, 39/10, 41/00, 41/04, 41/28)  
Other: Online: WPI, EPODOC, JAPIO

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 2313115 A (MCG CLOSURES LTD.) Note the outwardly extending sealing fin 16 in fig 2.	1-4,8,9 &13
Y	GB 2308353 A (BEESON AND SONS LTD.) Whole disclosure relevant.	16-23
Y	GB 2264108 A (BEESON AND SONS LTD.) Note screw-on stoppered closure and tapered bottle inner proximal wall in fig 1.	1-4,13 &16-23
Y	GB 1027844 (BUHLER) Note 'taper' of part 1 relative to the vertical inner threads 8 and the annular projections 7 on plug 6 that depends from base portion 3.	1-4, 8,9,10,13 &16-23
Y	US 5161707 (DUTT) Note the inwardly and outwardly extending sealing fins 29 & 31 abutting stop surfaces 35 & 41 with sealing edges 37 & 43 in figure 1a	1,2,3,4,8,9 ,10,13 &16-23
Y	US 4279353 (HONOMA) Note the sealing members 7 and circumferential bulge 8 in figures 1,3 & 5.	1,2,3,4 &16-23

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.





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Application No: GB 0028346.5  
Claims searched: 1-27

Examiner: Mike Leaning  
Date of search: 11 April 2001

GB 2264108 combines with US 4279353 to meet claims 1,2,3,4 & 13.  
GB 1027844 can combine with GB 2313115 to meet claims 1,2,3,4,8,9 & 13.  
GB 1027844 can combine with US 5161707 to meet claims 1,2,3,4,8,9,10 & 13.  
GB 2308353 combines with *any of the above combinations* to meet claims 16-23.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.